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OFFICE OF MANNED SPACE FLIGHT

APOLLO PROGRAM

INDEX AND FORMAT FOR CALIBRATION PROCEDURES

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PREPARED BY
APOLLO PROGRAM OFFICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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PREFACE

This document outlines the method of compiling, updating, and periodically distributing an Index of calibration procedures to MSF Center standards and calibration laboratories. The Index will list the calibration procedures that have been developed by the Center laboratories and those procedures that are either planned or in the process of development. In addition to the Index, details of the essential elements necessary for the development of complete, concise, and workable calibration procedures are presented. The application of the Index and Format for Calibration Procedures is outlined in paragraph 3.7 of the Apollo Metrology Requirements Manual (NHB 5300.2).

George A. Lemke
Director, Apollo
Reliability and Quality

INDEX AND FORMAT

FOR

CALIBRATION PROCEDURES

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

This document provides:

a. For the distribution of a Calibration Procedures Index that will contain a listing of existing Center-developed procedures. In addition, the Calibration Procedures Index will provide notification of procedures planned or being developed by each of the Centers.

b. The means for the dissemination and exchange of calibration information.

c. An outline of a standard format to be followed when calibration procedures are developed by the Centers.

2.0 APPLICABILITY

This document is applicable to all Center laboratories responsible for the calibration of standards or inspection, measuring, and test equipment used for the Apollo program. (Inspection, measuring, and test equipment, including tools and gages, will be referred to as "equipment.") The Centers, at their discretion, may apply applicable requirements to their Apollo sites and/or prime contractors.

3.0 DEFINITIONS

For the purpose of this document, the following definitions are established:

a. Calibration Procedures Index Card (Exhibit A). An Index Card completed by each Center to notify MAR-Q:

(1) That a Center plans to develop a specific calibration procedure.

(2) That a specific calibration procedure (new or revision) has been completed, verified, and approved.

b. Calibration Procedures Index. An index of planned and completed calibration procedures compiled by MAR-Q from the Index Cards. This index will be periodically distributed to all MSF Centers.

4.0 RESPONSIBILITIES

4.1 General

Each MSF Center will originate calibration procedures, based on their requirements, when applicable procedures are not available from the other Centers. Before originating a procedure, available procedures that have been developed by other sources (i.e., Manufacturer's instructions, DOD, Navy, Air Force) should be utilized to the fullest extent for pertinent information. To assure that procedures can be utilized by other Centers, each individual procedure will be developed based on the Procedure Preparation, paragraph 6.0 of this document.

4.2 Originator

The MSF Center originating a procedure will:

a. Determine from the latest issue of the Calibration Procedures Index that the specific required procedure has not been developed; is not planned for development by another Center; or, if planned, schedule requirements do not permit waiting for completion by another Center.

b. Review available procedures from other sources for background information.

c. Complete the Index Card when a new procedure is planned or started, entering the scheduled completion date in the appropriate space. Send the Index Card to:

NASA, Code MAR-Q
Federal Office Building 10B
600 Independence Ave., S. W.
Washington, D. C. 20546

d. Develop the procedure using the information in paragraph 6.0.

e. Verify the adequacy of the completed procedure by actual use of it to calibrate the standard or the "equipment."

f. Fill in an Index Card for each completed (new or revision) and verified procedure. This Index Card is in addition to that required in (c), above, and will be transmitted to:

NASA, Code MAR-Q
Federal Office Building 10B
600 Independence Avenue, S. W.
Washington, D. C. 20546

g. Send copies of the complete procedure (new and revised) to each of the other Centers (see paragraph 5.0) for their file and use.

4.3 NASA Apollo Quality Assurance Office (MAR-Q)

This central office will:

a. Consolidate the Index Cards as required to develop each issue of the Calibration Procedures Index. The procedures will be listed in sequence by model number, alphabetically by manufacturer, and/or alphabetically by nomenclature of the standard or "equipment," depending on usage experience.

b. Issue the Calibration Procedures Index to all MSF Centers.

c. File all completed Index Cards.

4.4 MSF Centers

Each Center will:

a. Review copies of all procedures received from the other Centers for internal application. These procedures, along with those developed locally, will become the standardized procedures for the calibration of standards and "equipment."

b. Communicate with the originating Center if the initial review discloses any discrepancies, or if discrepancies are noted during actual use.

c. Review the latest Calibration Procedures Index to insure that their file contains up-to-date procedures, and to insure that applicable procedures planned by other Centers are not being duplicated locally.

d. Communicate with counterparts at other Centers to resolve any specific problems.

5.0 MSF CENTER CONTACTS

Each Center, upon completion and verification of a procedure, will send a copy of the procedure to each of the other Centers; and MAR-Q will issue the

Calibration Procedures Index. The Center contacts for the purpose of these transmittals are listed as follows:

John F. Kennedy Space Center (NASA)
Kennedy Space Center, Florida 32899
Att: Chief, Instrument Calibration Branch

Manned Spacecraft Center (MSC)
Houston, Texas
Att: Chief, Standards & Q. A. Branch

George C. Marshall Space Flight Center (MSFC)
Huntsville, Alabama
Att: Chief, Environmental and Metrology Branch, R-QUAL-QM

These contacts will also be used when there is a requirement for technical discussions concerning calibration procedures and/or other metrology problems.

6.0 PROCEDURE PREPARATION

6.1 General Requirements

The originator will develop a required procedure using a standardized format as outlined below. This format is based on the Military Specification MIL-C-24133 (SHIPS), 12 February 1965 and this Specification will be used as a reference when a calibration procedure is being prepared. Each procedure will be prepared in an economical manner to allow for the efficient reproduction of copies.

Procedures will be written in simple, practical language so as to be readily understood, maintaining consistency of expression and terminology throughout the procedure. Direct grammatical construction, short sentences, and the use of articles will be employed to contribute to fluency and intelligibility. All statements will be clear and free from ambiguity.

The procedure layout will be arranged to conserve space without impairing legibility or resulting in a crowded appearance. Blank pages and wasted space will be avoided. Also:

a. Paragraphs, steps, notes, etc., will not be divided such that only the first or last line appears on a page.

b. Headings will not be placed at the bottom of a page unless at least two lines of text can be placed on the same page.

6.2 Format

6.2.1 Composition

Each procedure will be a complete and separate document arranged as follows:

a. Title Page.
b. Section 1. Introduction and Description.
c. Section 2. Equipment Requirements.
d. Section 3. Preliminary Operations.
e. Section 4. Calibration Process.
f. Sample Work Sheets.

6.2.2 Title Page

The title page will consist of the following information:

a. Originating Center identification.
b. Manufacturer, model number, and nomenclature of item being calibrated using the exact wording on nameplate.
c. Date of issue.
d. Originator's name and necessary approvals.
e. Originator's procedure number or identification code.
f. Indication of revision status. This may be an additional page following the title page and need not be inserted until a revision is made. The revision page will show:
   (1) Date of revision.
   (2) Identification of person initiating revision and necessary approvals.
   (3) Reason for revision.
   (4) Paragraph(s) of the procedure affected by revisions.

6.2.3 Section 1. Introduction and Description

This section will contain:

a. Complete identification of the standard or "equipment" to be calibrated, including model variations and/or modifications.

b. A description of the standard or "equipment," including performance ranges, accuracies, special conditions, usage, adapters, and/or test-lead requirements.

c. Environmental control details including temperature, humidity, vibration, cleanliness, etc., to assure measurements of required accuracy.

d. Instructions for special handling of a standard or "equipment" and required environmental controls after calibration.

e. Instructions for calibration of entire special "equipment" when it is composed of several individual items, since calibration of any one item may change the interrelated results of the configuration.

f. Source of information used in the Calibration Process (paragraph 6.2.6 a), i.e., manufacturer's manual, or procedure developed by another laboratory.

6.2.4 Section 2. Equipment Requirements

This section will list the following (see Exhibit B):

a. Required calibration equipment that will maintain the accuracy ratios as indicated in the Apollo Metrology Requirements Manual, NHB 5300.2, and Quality Program Provisions for Space Systems Contractors, NPC 200-2.

b. Required facility items such as liquid oxygen or nitrogen, dry ice, etc., that are necessary for the performance of the calibration operation.

c. Connectors, adapters, and all accessories required.

d. Minimum performance requirements of the calibration equipment, i.e., parameter and accuracy to allow the use of equivalent items when listed items are not available.

6.2.5 Section 3. Preliminary Operations

This section will contain:

a. Instructions for visual inspection, cleaning, and routine maintenance that is required prior to calibration operations.

b. A diagram of the initial setup required, specifying the type, length, and dress of leads, grounding, and other relative equipment placement, whenever such factors must be controlled.

c. Safety warnings and cautions.

d. Warmup instructions.

e. Instructions for obtaining and provisions for recording of item parameters and condition as received.

6.2.6 Section 4. Calibration Process

This section will contain:

a. Actual operations (to include adjustments, when applicable) listed in a series of sequential steps with applicable tolerances. For calibration that will be performed as recommended in the manufacturer's instruction manual, reference may be made if the procedure in the manual is adequate and provides for the maintenance of the required accuracies. Also:

(1) Reference will be made to output and input parameters rather than specific dial settings.

(2) The steps will be grouped in a logical sequence that will keep changes in connections, equipment setups, and control positions to a minimum.

b. Provisions for indicating that each step has been satisfactorily performed and data properly recorded.

c. Additional test diagrams when different steps require changing the initial setup.

d. Sealing instructions to prevent tampering between calibrations.

e. Provisions for documenting for the user of a standard or "equipment," any adjustments necessary due to changes in environments and instructions as to correct attitude and position to be maintained during usage.

f. Provisions for labeling or marking of each standard or "equipment" after calibration to indicate when next calibration is due. The label will include date of calibration and the identification of person performing the calibration operations. (When labeling or marking does not permit including this information, appropriate records must be maintained and must include a positive means of identifying the person performing the calibration.)

Provisions will include specific area of placement of the label or marking on the standard or "equipment" to insure a standard location on like articles.

NOTE

There will be a positive method of controlling blank labels to insure that they are used only by authorized personnel.

g. Clear indication on the standard or "equipment" if only a portion of the range or certain points of the range have been calibrated or tested.

h. A record keeping form or data sheet to include date, name of personnel performing calibration, final results, calibration time/cost, and other information pertinent to a specific item.

NOTE

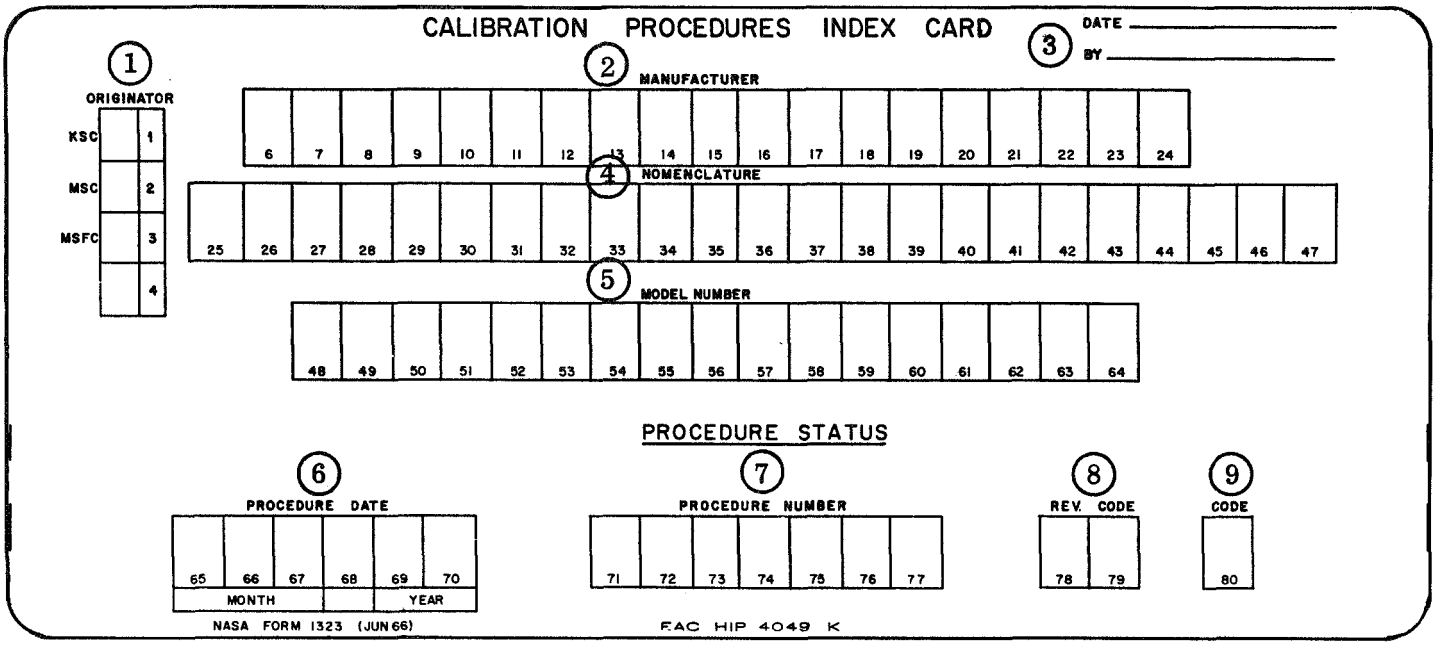
Items (d) through (h) might be a part of laboratory standard operating procedures, and if so, they need not be repeated in calibration procedures unless peculiar to a specific standard or "equipment."

6.2.7 Sample Work Sheets

Sample work sheets will be included whenever a number of reasonably complex calculations must be performed to derive the results of the test. Each work sheet will be arranged to accomplish the computation in the most efficient and convenient manner. Sample work sheets will be filled in with typical data to the extent necessary to illustrate the work process employed.

- EXHIBIT A -

INDEX CARD



INSTRUCTIONS FOR COMPLETING INDEX CARD

(1) Boxes 1 through 4 - Originating Organization:

Place a check mark in the appropriate box to indicate originating organization: KSC, MSC, or MSFC. If other than the three Centers mentioned, indicate originating organization to left of box 4, and check box 4.

(2) Boxes 6 through 24 -Manufacturer:

Name of manufacturer of standard or measuring equipment. Copy manufacturer's name directly from nameplate but do not use the word THE that might precede a manufacturer's name. For example, if nameplate reads, "THE ACME ELECTRONICS COMPANY," use ACME ELECTRONICS COMPANY: ACME will be noted in boxes 6 through 9; box 10 will be blank; ELECTRONICS will be inserted in boxes 11 through 21; box 22 will be blank, and CO will be inserted in boxes 23 and 24.

If the number of letters exceeds the number of boxes available, use only available boxes and write the complete name of the manufacturer on reverse side of the Index Card. For the above example, THE ACME ELECTRONICS COMPANY will be written on the reverse side of the Index Card.

(3) Date that the Index Card is completed and signature of individual submitting Card.

(4) Boxes 25 through 47 - Nomenclature:

Nomenclature of the equipment exactly as it appears on the equipment nameplate. Follow the same procedure as described for manufacturer's name when number of letters exceeds available boxes.

(5) Boxes 48 through 64 - Model Number:

Equipment model number exactly as it appears on the equipment nameplate. Careful attention must be paid to spaces, dashes, and slashes.

For example, model number 200 AB should not be copied as 200AB. The 200 will be noted in boxes 48 through 50; box 51 will be blank; and AB will be noted in boxes 52 and 53; boxes 54 through 64 will remain blank.

When one calibration procedure applies to several model numbers, initiate one card for each model number. For example: model 641 and model 641A require issuance of individual cards.

For the case where one procedure applies to a general group or category of equipment such as micrometers, pressure gages, etc., write the word ALL in boxes 48 through 50 and leave boxes 51 through 64 blank.

Particular care must be taken to distinguish the letter "I" from the numeral "1".

(6) Boxes 65 through 70 - Date:

Month and year for the date that the procedure will be completed if in the planned (P) status or the date of the procedure if it is completed (C) - see (9). For example, a procedure planned for completion in December of 1966 will have DEC noted in boxes 65 through 67; box 68 will be blank, and 66 will be inserted in boxes 69 and 70. All months will use the first three letters of the month and box 68 will always be blank.

(7) Boxes 71 through 77 - Number:

Originator's assigned procedure number.

(8) Boxes 78 and 79 - Revision:

Revision code or designation assigned to the procedure. If revisions are designated by A, B, C,....etc., write the letter in box 78 and leave box 79 blank. If numbers are used such as 1, 2,....13, etc., write 01 (place 0 in box 78 and 1 in box 79), 02,....13 (place 1 in box 78 and 3 in box 79).

(9) Box 80 - Status Code:

Letter P designates a procedure which is planned, a C designates a completed procedure.

- EXHIBIT B -

TYPICAL EQUIPMENT REQUIREMENTS LIST

Item	Minimum Use Specifications	Calibration Equipment
Frequency meter	Frequency range, 1.7 to 4.1 GHz, ±0.25%. Dial resolution, 2 MHz max.	FXR N410A
Electronic counter	Frequency range, 900 Hz to 3 MHz. Accuracy, ±0.1%. Input sensitivity, 1 volt max.	Hewlett-Packard 524 series or FR-38A/U (AN/USM-26)
Power meter	Power range, 0.1 to 10 mw. Accuracy, ±5%. Frequency range, 1.7 to 4.1 GHz.	Hewlett-Packard 430 power meter with 476B bolometer mount, or Polarad P-3 power meter with TM-1 thermistor mount
Coaxial termination	Impedance, 50 ohms. Frequency range, 1.7 to 4.1 GHz. VSWR, 1.2 max.	Narda 37 ONM or Weinschel 535-MN
Pulse generator	Pulse rate, 1000 pps. Pulse width, 1 usec. Amplitude, 20 v p-p across 50 ohms. Rise time, 0.5 sec max. Decay time, 1.2 sec max. Output sync pulse, 0.5v min. Pulse delay, 0 to 10 sec.	Hewlett-Packard 212A or AN/USM-27

NOTE

Minimum Use Specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

The instruments itemized in this procedure (and the listing by make or model number) carries no implication of preference, recommendation, or approval. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in the procedure.

DATA SYSTEM